ORIGINAL ARTICLE

Urodynamic assessment of bladder and urethral sphincter function before and after robot-assisted radical prostatectomy

O.S. Barnoiu a,*, R. Vozmediano-Chicharro a, E. García-Galisteo a, J. Soler-Martinez a, J.M. del Rosa-Samaniego a, J. Machuca-Santacruz b, V. Baena-Gonzalez a

a Servicio de Urología, Hospital Carlos Haya, Málaga, Spain
b Servicio de Urología, Hospital Virgen de la Victoria, Málaga, Spain

Received 13 March 2013; accepted 17 July 2013
Available online 8 December 2013

KEYWORDS
Urodynamic study; Robot-assisted prostatectomy; Urinary incontinence; Bladder dysfunction; Voiding dysfunction

Abstract
Introduction: Affectation of the bladder after open prostatectomy is demonstrated. Decrease in bladder capacity and bladder compliance, detrusor hyper-or hypo-activity and voiding dysfunction are observed. We propose to investigate the effects of robotic surgery on bladder and sphincter function through the comparative study of preoperative and postoperative urodynamic values 3 months after prostatectomy.

Material and methods: Prospective study of 32 consecutive patients undergoing robotic prostatectomy. They all underwent urodynamic study one month before the intervention and 3 months after the radical prostatectomy.

Results: Twenty-five percent of patients undergoing robotic prostatectomy showed detrusor hyperactivity accompanied by a decrease in bladder compliance of 30.2 to 21.8 ml/cmH 2 O. Urethral profile showed diminished functional length of 67 to 44 mm and decreased maximum urethral pressure of 48.5 to 29.3 cmH 2 O. After robotic prostatectomy 21.8% of patients had detrusor hypoactivity, obstruction decreased between 28.1 and 12.5%.

Conclusions: Decreased bladder compliance, detrusor hypo- or hyperactivity and obstruction improvement observed in the study of the flow pressure have been associated with sphincter involvement. It is part of the complex of lower urinary tract dysfunction that occurs after robotic prostatectomy.

© 2013 AEU. Published by Elsevier España, S.L. All rights reserved.

* Corresponding author.
E-mail address: barnoiu@yahoo.com (O.S. Barnoiu).
PALABRAS CLAVE
Estudio urodinámico; Prostatectomía radical asistida por robot; Incontinencia urinaria; Disfunción vesical; Disfunción de vaciado

Valoración urodinámica de la función vesical y esfinteriana antes y después de la prostatectomía radical asistida por robot

Resumen
Introducción: Está demostrada la existencia de una afectación vesical tras la prostatectomía abierta en relación con la disminución de la capacidad vesical y la acomodación, la hiperactividad o la hipoactividad y la disfunción de vaciado. Comparando el estudio urodinámico preoperatorio con el realizado a los 3 meses tras la prostatectomía, nos proponemos investigar el impacto de la cirugía robótica sobre la función vesical y la esfinteriana.

Material y métodos: Hemos evaluado de forma prospectiva a 32 pacientes que de manera consecutiva han sido intervenidos de prostatectomía robótica. A todos estos pacientes se les ha realizado un estudio urodinámico un mes antes de la intervención y otro a los 3 meses tras la prostatectomía radical.

Resultados: Hemos detectado una hiperactividad del detrusor en un 25% tras la prostatectomía robótica con una disminución de la acomodación vesical de 30,2 a 21,8 ml/cmH₂O. En el perfil uretral hemos encontrado una disminución de la longitud funcional uretral de 67 a 44 mm y de la presión uretral máxima de 48,5 a 29,3 cmH₂O. La hipoactividad se ha demostrado en el 21,8% de los pacientes y la obstrucción ha disminuido del 28,1 al 12,5% tras la prostatectomía robótica.

Conclusiones: La disminución de la acomodación vesical, la hiperactividad o hipoactividad detrusoriana y la mejora de la obstrucción en el estudio de presión-flujo se asocian a la afectación esfinteriana formando parte de un síndrome complejo de disfunción del tracto urinario inferior que aparece tras la prostatectomía robótica.

© 2013 AEU. Publicado por Elsevier España, S.L. Todos los derechos reservados.

Introduction
Urinary incontinence (UI) is a postoperative complication of robot assisted radical prostatectomy (RARP) that has a significant impact on the quality of life of these patients. UI is the major lower urinary tract disorder, but not the only, after radical prostatectomy. A relationship between bladder disorder and open prostatectomy has been proved. There is a reduction in bladder capacity and compliance, bladder over- and hypo-activity and emptying dysfunction. These findings can be present before surgery or appear de novo as consequence of denervation and devascularization of the bladder, long time intravesical obstruction evolution or because the patients develop new voiding patterns. The proper way to assess objectively these findings is by urodynamic study (US) at 3 months, because the changes are not significant from this period.

Laparoscopic radical prostatectomy does not avoid bladder injury but it is associated with less impairment than open surgery, without differences in post-operative urethral function. Undoubtedly, several factors like surgeon and surgical technique have an important impact on functional outcomes and in recovery of urinary continence. Thus, less incontinence rates, statistically significant, have been achieved with robotic surgery in comparison with conventional laparoscopic surgery.

We propose to investigate the effects of robotic surgery on bladder and sphincter function comparing preoperative urodynamic study with the study at 3 months after prostatectomy.

Material and methods
Thirty-two consecutive patients undergoing robotic prostatectomy in our service between October 2011 and June 2012 have been assessed prospectively. One month before surgery, urodynamic study has been performed for each patient and a second US at 3 months after radical prostatectomy. The Ethic Committee of our center approved the study and all patients provided written informed consent.

Preoperatively, all patients were incontinent with an ICIQ-SF score of 1 (ICIQ-SF Spanish version). Pelvic floor exercises and habitual physical activity, before and after surgery, were recommended to all patients.

Preoperative variables analyzed were: age, comorbidities – measured with Charlson comorbidity index (CCI) and with CCI age-adjusted –, body mass index (BMI), lower tract urinary symptoms assessed with IPSS questionnaire, sexual function assessed by IIEF-5 questionnaire, prostate volume measured by transrectal ultrasound, preoperative PSA, Gleason score and clinical stage.

The same RARP technique has been performed by 3 specialists in robotic surgery: descending approach, intraperitoneal, with bladder release and extraperitoneal access to Retzius’ space. Periprostatic fat is removed and endopelvic fascia is opened. In all cases, bladder neck sparing has been tried. After the bladder neck is dissected, retrovesical space is exposed, vas deferens is properly identified and cut and seminal vesicles are completely released. Following, through interfascial approach bilateral neurovascular bundles are released. After dissection and ligation of Santorini complex, urethra is cut, preserving the maximum possible length of the urethral stump in order to preserve external sphincter function. Urethrovesical anastomosis is performed using Van Velthoven technique (running suture).

Finally, leakage test is carried out in order to verify the proper urethrovesical anastomosis, followed by a drainage placement and removal of the surgical specimen. At the end of the surgery, a 20 Ch Foley catheter is placed and
maintained during 5–7 days. The catheter is removed after leakage tested by cystography.

Intraoperative variables were: operative time and intraoperative bleeding, the sparing of neurovascular bundles (uni- or bilateral; intra-, inter- or extra-fascial) and the need for bladder neck reconstruction.

In the immediate postoperative period, surgical complications have been assessed according to Clavien-Dindo classification11 and with weekly cystographic control. One month after prostatectomy pathologic staging has been assessed as well as the presence of positive surgical margins. At 3 months after surgery, the presence of UI and stenosis of urethovesical anastomosis were evaluated.

One month before surgery and at 3 months after intervention, US was performed using Medical Measurement Systems® (MMS) device and following a methodology according to ICS specifications, for example the Good Urodynamic Practices.12 The procedure was a free flowmetry. Urodynamical variables analyzed included free voided volume, free maximum flow rate, the shape of flow curve and residual volume (normal <10% of the volume voided) after free flowmetry. Then, a resting urethral profile was performed using the maximum urethral closure pressure at the rest and in the voluntary contraction. Data recorded were: the highest value, the urethral functional length and the shape of profilometry curve (sphincter deficiency is defined as maximal urethral closure pressure <20 cmH₂O). Bladder-to-urethra pressure transmission with effort, cough or Valsalva maneuver, was detected in the dynamic urethral profile A infusion rate of 2 ml/min or 40 drops/min and a removal rate of the catheter of 1 mm/s (by MMS withdrawal arm) were used for carrying out the urethral pressure profile.

Bladder capacity and bladder compliance (impaired compliance was defined as <12.5 ml/cmH₂O) were documented by cystometry. Bladder overactivity was also assessed (characterized by uninhibited contractions at 3 months with a Valsalva leak point pressure of 200–300 cc) and sphincter deficiency was defined as VLPP < 60 cmH₂O.

Detrusor pressure at maximum flow and the grade of detrusor contractility (according to the Schaefer nomogram) were recorded. According to bladder contractility index (BCI) bladder contractility was classified as strong (BCI > 150), normal (BCI 100–150) and weak contractility (BCI < 100). Bladder obstruction was evaluated according to ICS nomogram that measures the bladder outlet obstruction index (BOOI). BOOI greater than 40 equals obstructed; BOOI ranging from 20 to 40 equals equivocal; and BOOI less than 20 equals unobstructed UI at 3 months after prostatectomy was objectively confirmed by the use of a 24-h pad test and with urodynamic testing.

Statistical analysis has been carried out using Statistical Package for Social Sciences (SPSS®, Inc.) for Windows. Frequency of each variable and causes of the incontinence, population characteristics and differences between pre- and post-operative US relating it with postoperative UI were analyzed.

Results

At 3 months after RARP, 37.5% of patients showed UI (12 patients). In 75% of patients (9 patients), sphincter deficiency has been the only cause of post-operative UI, in one patient (8.3%) bladder overactivity was the only cause and two patients (16.6%) had a mixed cause.

Mean age of the population was 59.4 ± 6.3 years (46–71) and the Charlson comorbidity index (CCI) was 2.19 ± 0.4 and CCI age-adjusted was 3.7 ± 0.7. Mean body mass index was 28.3 ± 2.6 kg/m², mean IPSS 10.4 ± 8.5 and mean IIEF 21.3 ± 3.7. Mean prostate volume measured by transrectal ultrasonnd was 41.8 ± 17.3 g and mean PSA 6.25 ± 2.25 ng/dl (Table 1).

Intra- or interfascial bilateral nerve sparing has been performed in 93.7% of patients (30 patients); 9.4% of them (3 patients) required bladder neck reconstruction. In the immediate postoperative period, one patient developed a urinary fistula resolved with conservative treatment. One week after surgery, another patient had a small leak of contrast material, being necessary to maintain bladder catheter for 7 days more. No patient with stenosis of urethovesical anastomosis has been found, until 3 months after surgery.

After surgery, we have found an increase of Qmax without statistical significance (from 15.7 to 17.2 ml/s) and de novo bladder overactivity in 3 patients (9.3%). The number of inhibited contractions has increased from 18.5% (6 patients) to 25% (8 patients); no significant difference has been found in the postoperative US. Uninhibited contractions showed by one patient in preoperative period have not been found in postoperative US. Bladder compliance has decreased from 30.2 to 21.8 ml/cmH₂O. Two patients (6.25%) showed de novo impairment and decreased bladder capacity (from 254 to 243 cc), although no significant differences have been observed (Table 2).

Regarding urethral profile, statistically significant decreases in maximum urethral closure pressure (from 48.5 to 29.3 cmH₂O) and in urethral functional length (from 67 to 44 mm) have been found (p = 0.019 and 0.015 respectively). Bladder-to-urethra pressure transmission has diminished after prostatectomy (from 74.5 to 56.1%), no significant differences have been found.

In the flow-pressure study we have found in 2 patients a decrease of detrusor pressure at Qmax (from 58.7 to 50.1 cmH₂O) along with de novo hypocontractility and an obstruction improvement from 28 to 6.25% (p = 0.029).

Discussion

In Ficarra et al.,8 in a systematic review and meta-analysis of 51 articles, compared the prevalence of UI after robot-assisted radical prostatectomy vs. retropubic or laparoscopic radical prostatectomy. In robot-assisted surgery UI rates ranged from 4 to 31% after one year, with a mean value of 16% using a no pad definition. Considering a no pad or safety pad definition, the incidence ranged from 8 to 11%, with a mean value of 9%. For the first time, the cumulative analysis showed significant advantages for RARP in comparison with open and laparoscopic surgery in terms of UI.

UI after RARP is multifactorial and among the possible causes have been described, besides sphincter deficiency, the hyper-contractility of the detrusor in the bladder dysfunction. In our series, we have found: sphincter deficiency (75%), bladder overactivity (17%) and mixed cause (8%).
Urodynamic assessment of bladder and urethral sphincter function

Table 1  Population characteristics and descriptive statistics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Mean ± typical deviation</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>46–71</td>
<td>59.4 ± 6.3</td>
<td></td>
</tr>
<tr>
<td>Charlson comorbidity index (CCI)</td>
<td>2–3</td>
<td>2.19 ± 0.4</td>
<td></td>
</tr>
<tr>
<td>CCI adjusted by age</td>
<td>2–5</td>
<td>3.7 ± 0.7</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>17.9–33.4</td>
<td>28.3 ± 2.6</td>
<td></td>
</tr>
<tr>
<td>Preoperative IPSS</td>
<td>1–31</td>
<td>10.4 ± 8.5</td>
<td></td>
</tr>
<tr>
<td>Preoperative IIEFS</td>
<td>16–25</td>
<td>21.3 ± 3.7</td>
<td></td>
</tr>
<tr>
<td>Prostatic volume (cc)</td>
<td>11–82</td>
<td>41.8 ± 17.3</td>
<td></td>
</tr>
<tr>
<td>PSA (ng/dl)</td>
<td>3.6–12</td>
<td>6.25 ± 2.25</td>
<td></td>
</tr>
</tbody>
</table>

Gleason
- ≤6                        84.4
- 3 + 4                     12.5
- 4 + 3                     3.1

Clinical stage
- cT1c                      81.3
- cT2a                      15.6
- cT2c                      3.1

Operative time (min)         90–500          161 ± 67

Intraoperative bleeding (cc) 200–1600        484 ± 135

Complications (Clavien Dindo scale)
- 0                        81.3
- I                        15.6
- IIA                      3.1

Urinary fistula              6.2

Surgical margins
- Negative                  87.5
- Apex                      3.1
- Base                      3.1
- Lateral                   6.2

Pathological stage
- pT2a                      37.5
- pT2b                      46.8
- pT2c                      9.4
- pT3a                      6.2

Table 2  Changes in preoperative urodynamic study and at 3 months.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preoperative</th>
<th>3 months</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qmax (ml/s)</td>
<td>15.7 (3–23)</td>
<td>17.2 (7–25)</td>
<td>0.712</td>
</tr>
<tr>
<td>UC</td>
<td>18.7% (6 patients)</td>
<td>25% (8 patients)</td>
<td>0.594</td>
</tr>
<tr>
<td>De novo</td>
<td>–</td>
<td>9.3% (3 patients)</td>
<td></td>
</tr>
<tr>
<td>Bladder compliance (ml/cmH₂O)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Decreased</td>
<td>28.1% (9 patients)</td>
<td>34.3% (11 patients)</td>
<td>0.704</td>
</tr>
<tr>
<td>Bladder capacity</td>
<td>254 (121–435)</td>
<td>243 (141–342)</td>
<td>0.2</td>
</tr>
<tr>
<td>MUCP (cmH₂O)</td>
<td>48.5 (19–63)</td>
<td>29.2 (8–55)</td>
<td>0.019</td>
</tr>
<tr>
<td>UFL (mm)</td>
<td>67.4 (24–148)</td>
<td>44.6 (17–61)</td>
<td>0.015</td>
</tr>
<tr>
<td>Transmission</td>
<td>74.5% (20–100)</td>
<td>56.1% (8–100)</td>
<td>0.169</td>
</tr>
<tr>
<td>Detrusor pressure (cmH₂O)</td>
<td>58.7 (22–98)</td>
<td>50.1 (21–68)</td>
<td>0.26</td>
</tr>
<tr>
<td>Hypocontractility</td>
<td>15.6% (5 patients)</td>
<td>21.8% (7 patients)</td>
<td>0.41</td>
</tr>
<tr>
<td>Obstruction P/F</td>
<td>28.1% (9 patients)</td>
<td>6.25% (2 patients)</td>
<td>0.029</td>
</tr>
</tbody>
</table>

UC: uninhibited contractions; UFL: urethral functional length; MUCP: maximum urethral closure pressure; Qmax: maximum flow.
In the study of Ficazzola and Nitti, including 60 patients evaluated with multichannel video urodymanics 6 months after radical prostatectomy, intrinsic sphincter deficiency was demonstrated in 54 patients (90%). Some component of bladder dysfunction was seen in 27 patients (45%), including detrusor instability in 24 and decreased compliance in 3.

In Giannantoni et al. study it was demonstrated for first time the impairment of bladder compliance in 20.4% of patients and of detrusor contractility in 42.8% of patients at baseline and in 61.2 and 42.8% at 1 and 8 months, respectively. One year later, in a 3-year follow-up prospective study of 54 patients, these authors observed a reduced bladder compliance in 28.1% of patients and de novo detrusor hypocontractility in 51% of patients at 8 months and persisted in 25% of cases 3 years later. Similarly to our series, in a small number of patients some urodynamic dysfunction documented before the intervention disappeared soon after probably due to dramatic resolution of the obstruction. In a systematic review, Porena et al. found impaired bladder compliance in 8–39% of patients and was de novo in about 50%.

Among surgery-dependent factors, surgeon factor is undoubtedly one of the most important in terms of functional outcomes. In our study, bilateral intra- or inter-fascial nerve sparing has been performed in the most of cases (93.7%), requiring bladder neck reconstruction only the 9.4% of the patients. Learning curve of 3 surgeons exceeded the 50 cases, that is the number necessary for the robot control. Similarly, some authors consider between 100 and 200 the number of procedures required to achieve an adequate continence in this technique. In our old series, no differences were found among 3 experts in robotic surgery of our service.

At 3rd month, no patient with stenosis of urethrovésical anastomosis has been recorded. In the two patients who showed obstruction in US, the Qmax in the uro-flowmetry was 12.5 and 15 ml/s, respectively, without post-micturition residue and in the urethrocytostoscopy did not show a stenosis of the anastomosis.

Matsukawa et al. assessed the impact of laparoscopic prostatectomy on vesico-urethral function and compare it to that of open prostatectomy. Laparoscopic prostatectomy has a negative impact on storage function by impairing function of the urethral sphincter and decreasing bladder compliance. These authors have not found significant differences in postoperative urethral function between open and laparoscopic prostatectomy. However, bladder compliance was significantly lower and incidence of detrusor overactivity was significantly higher in patients who underwent open prostatectomy.

Because US is an invasive procedure, the series studies are limited to a small number of patients. However, conclusions could be achieved in different studies: Guziak et al. in 27 patients series, Pfister et al. in 20 patients series and John et al. in 39 patients. The John et al. study include a quite selected series of patients, most of them were young patients, without significant comorbidities and without erectile dysfunction, with medium-sized prostate with organ-confined cancer. All these patients underwent bilateral nerve sparing, bladder neck reconstruction was not necessary in any case and no important postoperative complications were described. All these factors are favorable for the recovery of the voiding dynamics.

We can conclude that sphincter deficiency is the most frequent cause of UI after RARP. The most striking urodynamic changes of our series after RARP have been, in the urethral profile, the decrease in the maximum urethral closure pressure and in the functional urethral length, and the improvement of the obstruction, in the flow pressure study. Postoperative US, in certain cases, can help to achieve a precise diagnosis of preexisting dysfunctions, to initiate appropriate therapy and to prevent the occurrence of postoperative IU.

Conflict of interests

The authors declare no conflict of interests.

References


